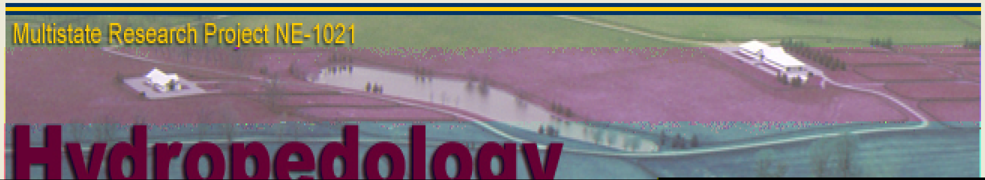

Multistate Research Project NE-1021
Hydropedology

NE-1021 Multi-State Project: Hydropedology: Genesis, Properties, and Distribution of Hydromorphic Soils

NE-1021 Goals (the big picture) 2005-2009

- improve our understanding of the processes, characteristics, and interpretations of saturated, hydric, and subaqueous soils;
- establish a framework for the integration of studies investigating soils from a hydropedological approach throughout the northeastern US.

NE-1021 Multi-State Project: Hydropedology: Genesis, Properties, and Distribution of Hydromorphic Soils

Northeast NCSS Participants

- Martin Rabenhorst (MD)
- Brian Needelman (MD)
- Mark Stolt (RI)
- Henry Lin (PA)
- Jim Thompson (WVA)
- Bruce Vasilas (DE)
- Peter Veneman (MA)
- Laurie Osher (ME)
- Patrick Drohan (PA)
- John Galbraith (VA)

NE-1021 Multi-State Project:

Project Outputs

Outreach

- Field Tours
  - Northeast Regional Graduate Student Pedology
    - West Virginia
    - Virginia
    - Pennsylvania
  - World Congress 2006
  - NENCSS Tours
  - Workshops
- Collaborations
  - Osher, Stolt, and Rabenhorst
  - Drohan and Stolt

NE-1021 Multi-State Project:

Project Outputs

Outreach

- Publications (or similar)

Jespersen and Osher (subaqueous soils)

Stolt, Drohan, and Richardson (carbon)

Rabenhorst, Hively, and James (hydric soils)

New additions to Keys to Soil Taxonomy for subaqueous soils (Wassents and Wassists)

Glossary of terms for subaqueous soils (landforms and parent materials); Incorporated into NSSH

Hydric soil indicators:

TA6 mesic spodic test indicator added to national manual

Investigations to support TF2 in New England

NE-1021 Papers, Presentations, and Participants at 2009 SSSA National Meetings

- The Role of Soil Stratigraphy and Soil Moisture Dynamics in Stream Flow in a Mediterranean Catchment.Alexandre Swarowsky*, **Anthony O'Geen** and **Randy Dahlgren**.
- Repeated Electromagnetic Induction Surveys for Understanding Landscape Soil and Water Dynamics. Qing Zhu*, **Henry Lin** and James Doolittle.
- Soil and Landscape Factors Influencing Microbial Reduction of Iron Oxides. **Martin C. Rabenhorst***,Michelle Hetu, Vera Jaffe and Philip Zurheide
- Understanding Pedologic-Hydrology Relationships Across the Landscape: Carbon Accounting and Denitrification. **Mark H. Stolt***, Sean Donohue, Margot K. Payne, Christina Pruett and Arthur Gold.
- Endogenous and Exogenous Carbon Sequestration in a Constructed Flow-through Wetland Receiving Agricultural Runoff. Jonathan Maynard*, **Anthony O'Geen** and **Randy Dahlgren**.
- Development of Subaqueous Soil Interpretations: Eelgrass Restoration, Heavy Metal Accumulations and Carbon Storage. Christina Pruett* and **Mark Stolt**.
- Developing Subaqueous Soil Interpretations: Shellfish and Dredged Material Placement. Alexander R. Salisbury*, and **Mark H Stolt**.
- The Extent and Characterization of Freshwater Subaqueous Soils of Black Moshannon Lake, Pennsylvania. Emilie Erich*, **Patrick Drohan**, Mary Kay Lupton, Katherine S. Lindeburg, Elizabeth Boyer and Joseph Bishop.
- Functional Soil Mapping for Soil Moisture and Crop Yield Management in an Agricultural Landscape. Qing Zhu*, **Henry Lin** and James Doolittle.
- Confidence Intervals for Estimated Saturated Hydraulic Conductivity Measured Using Compact Constant Head Permeameters. John F. Beck*, **Jim Thompson**, Michael Harman, Philip Schoeneberger, Larry West and Skye Wills.
- Factors Controlling the Soil Moisture Spatial-Temporal Variability in the Shale Hills Watershed: A Hydropedologic Perspective. Kenneth Takagi* and **Henry Lin**.

NE-1038 Multi-State Project: Hydropedology: Genesis, Properties, and Distribution of Hydromorphic Soils

Objectives

- Evaluate the use of **field indicators of hydric soils** to characterize wetland hydroperiods;
- Test the effectiveness of proposed hydric soil **indicators to identify "problem hydric soils";**
- Test **monitoring protocols used to identify reducing conditions** to determine if they are effective within a range of soil conditions;
- Investigate the **hydraulic properties of hydromorphic soils with episaturation.**
- Initiate the development of **subaqueous soil-based use and management interpretations** for applications in shallow-subtidal habitats;
- Investigate the spatial extent **freshwater subaqueous soils** in riverine settings;
- **Quantify and better understand carbon pools** in a range of hydromorphic, wetland, created wetland, and subaqueous soil settings;
- Test the **relationship between surface soil C and field indicators of hydric soils;**
- **Test the application of various digital geospatial analysis tools to model C-pools** across the landscape based on point and polygonal carbon data.

NE-1038

Northeast NCSS Participants

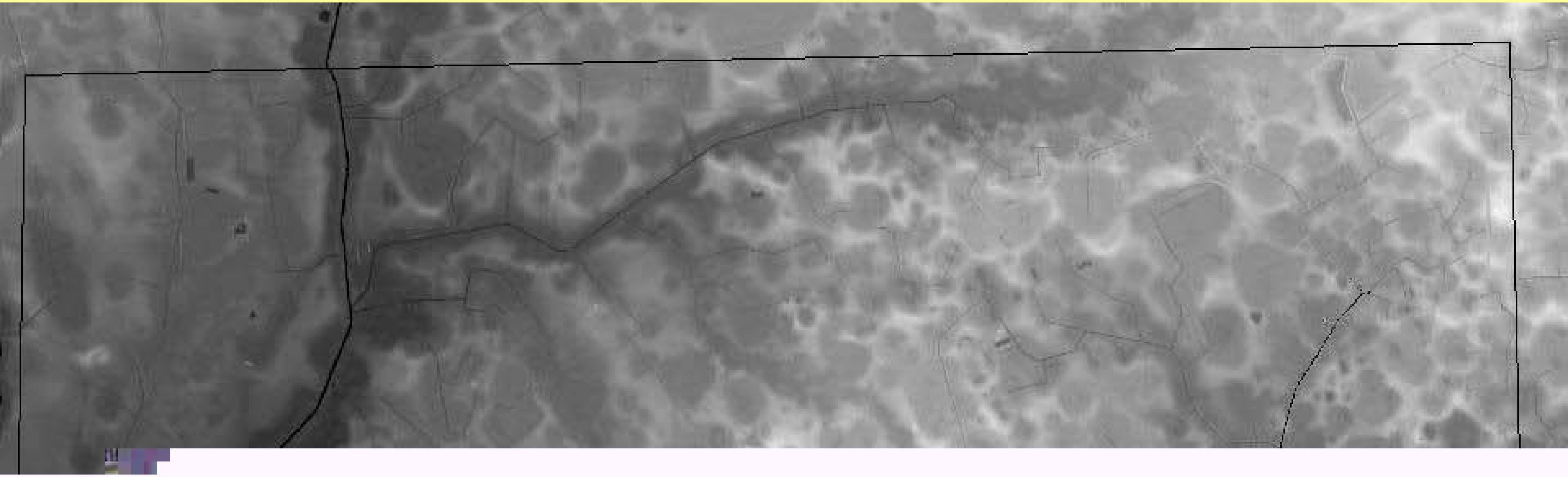
- Martin Rabenhorst (MD)
- Brian Needelman (MD)
- Jim Thompson (WVA)
- Bruce Vasilas (DE)
- Mark Stolt (RI)
- Henry Lin (PA)
- Peter Veneman (MA)
- Patrick Drohan (PA)
- John Galbraith (VA)

M. C. Rabenhorst With Graduate Student Michelle Hetu

- *Assessing Reducing Conditions in Soil along a Topohydrosequence*
- *Effects of total carbon and temperature on reducing conditions in soils along a topohydrosequence: A mesocosm experiment*

M. C. Rabenhorst with Graduate Student Dan Fenstermacher

- *Potential Carbon Storage in Delmarva Bay Wetlands*



M. C. Rabenhorst with Graduate Student Annie Rossi

- *Recognition and Pedogenesis of Sandy Hydric Soils in the Near-Coastal Portions of the Mid-Atlantic Region*

Carbon Sequestration in Piedmont Slope Wetlands

Bruce Vasilas, UD

Lenore Vasilas, NRCS

Mike Wilson, NRCS

Objectives: To assess the quantity and vertical distribution of SOC in slope wetlands

Field Indicators of Hydric Soils in Disturbed Soils

Bruce Vasilas, UD

Objective: Identify field indicators in soils subjected to anthropogenic disturbance

Disturbed Soils-Preliminary Results

- Paired disturbed and undisturbed sites usually have one Field Indicator in common.

Fragipan Influence on Hydropedological Properties of Benchmark Soilscapes in West Virginia

Investigate the hydraulic properties of hydromorphic soils with episaturation

- Objective: Evaluate hydraulic properties on benchmark soils
- Study area: 50 ha watershed of fragipan dominated soils
- Methods: Link observed pedology with the real-time sensor data
  - Sensors record hydro activity from surface through vadose zone
  - Data recorded at 10 minute intervals
- Goal: Extrapolate the resultant data, model, and interpretations across similar landscapes

Confidence Intervals for Estimated Saturated Hydraulic Conductivity

How many in situ Ksat measurements are necessary to measure Ksat using compact constant head permeameters?

- There are a minimum number of samples necessary
- Fewer “n” fail to meet a desired confidence level
- Additional “n” beyond target confidence is costly
- Objectives
  - Determine the threshold number of samples
  - Determine at what spacing observations should be made

Understanding Pedologic-Hydrology Relationships Across the Landscape

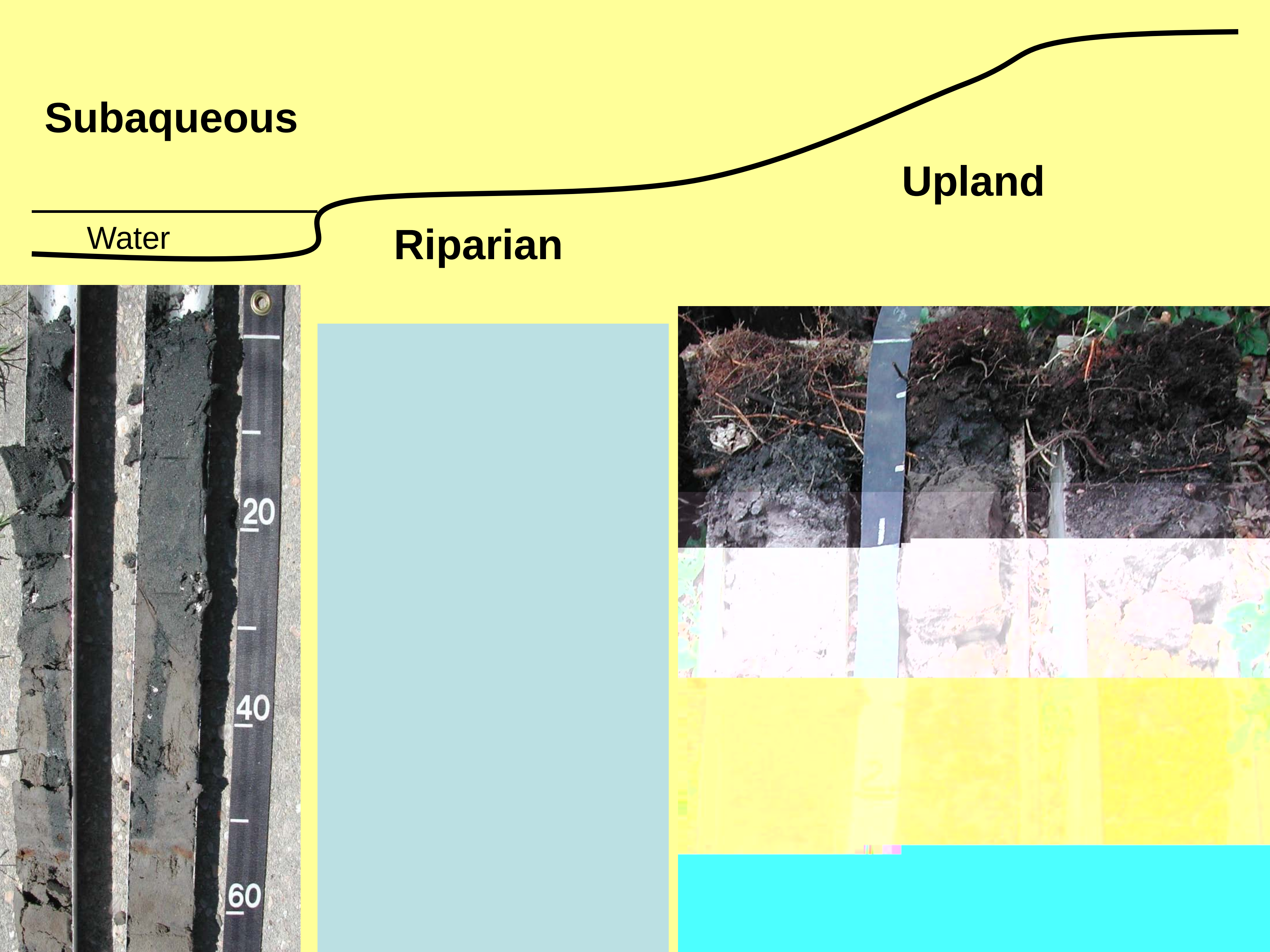
Funding Sources

- USDA-NRI
- NOAA
- Rhode Island Sea Grant
- Rhode Island-AES

Carbon Accounting and Denitrification

Mark Stolt, Sean Donohue, Maggie Payne, Chrissy Pruett, Art Gold, Peter Groffman, Gary Blazejewski, Noel Gurwick, Aletta Davis, and Matt Richardson

Southern New England- Glaciated; primarily Forested


Subaqueous
Water
Riparian
Upland
20
40
60

Groundwater Denitrification Function?

Subaqueous

Yes, but?

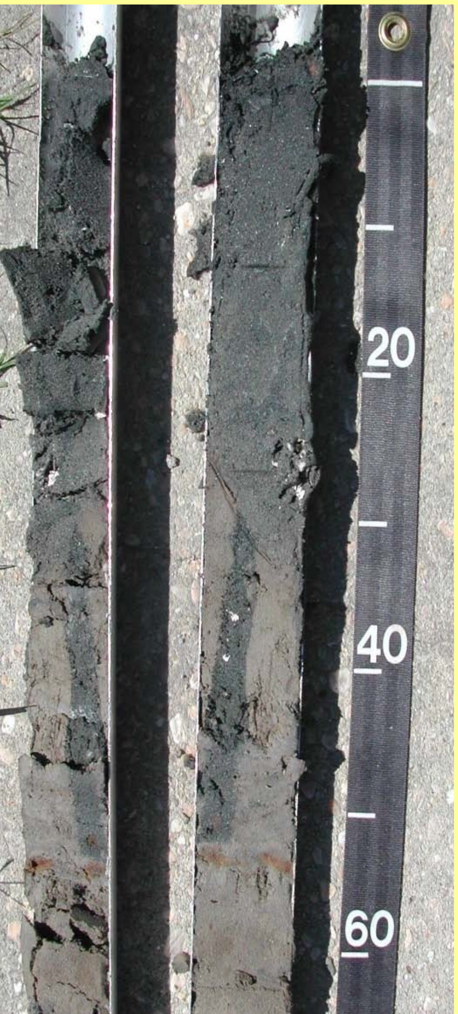
Water

Riparian

Yes, but ?

Upland

Minimal



Groundwater Denitrification Function?

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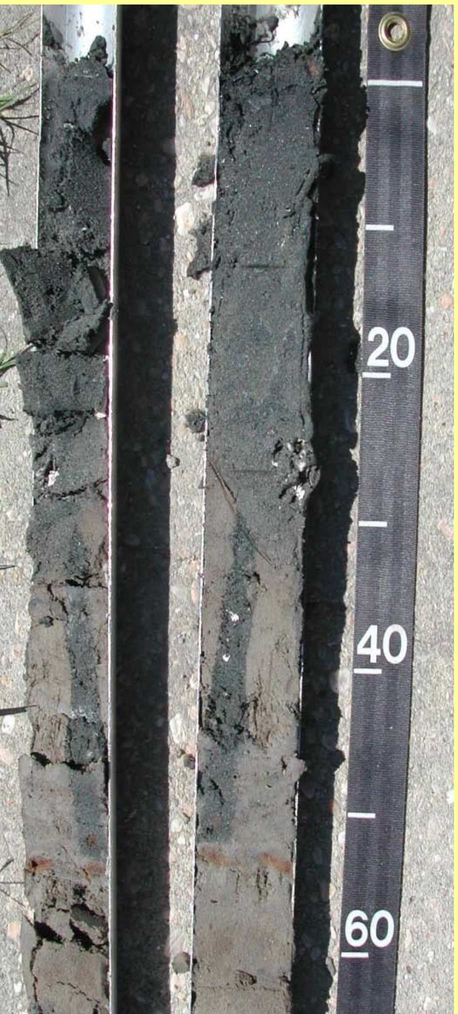
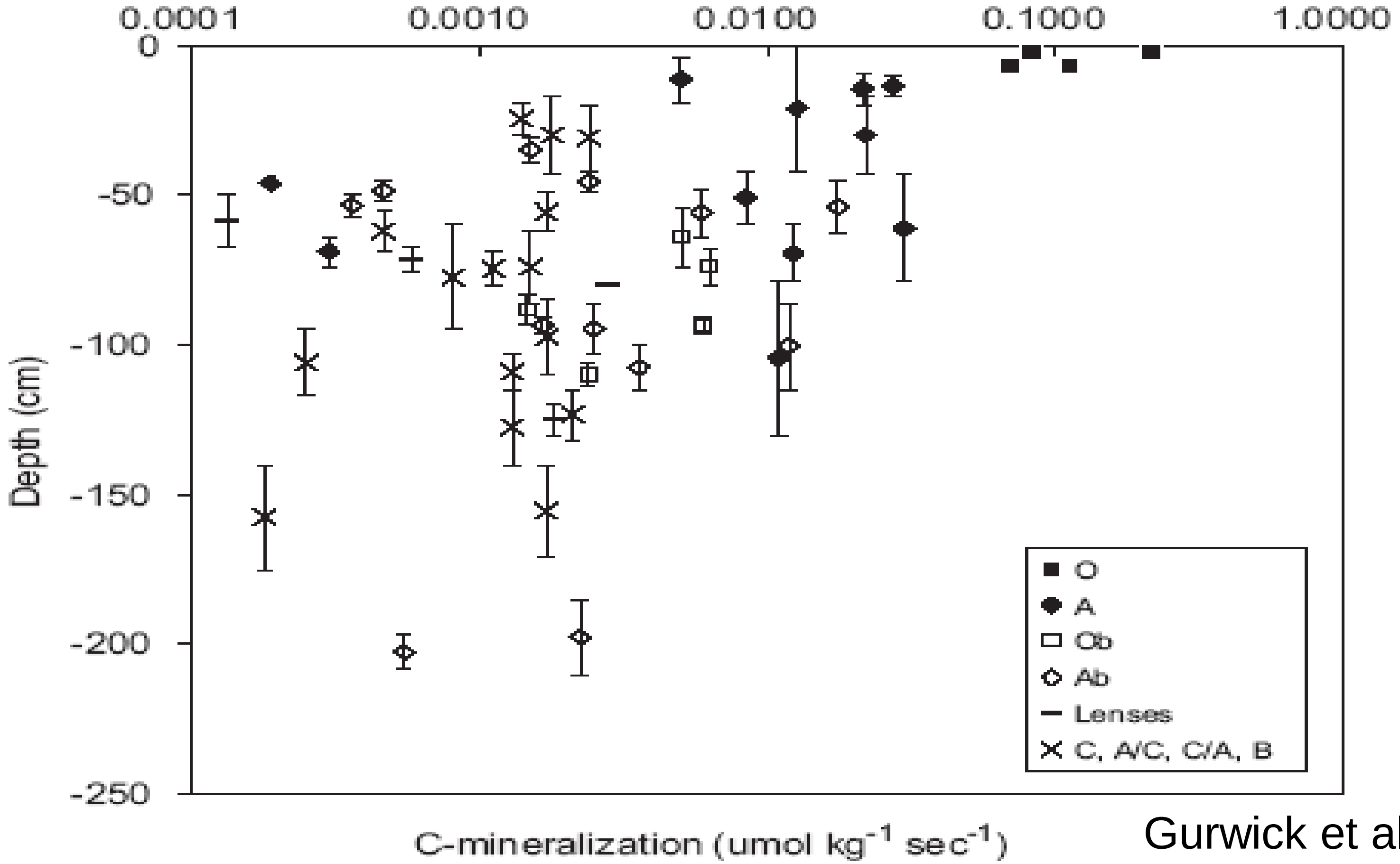


Does function follow form?



Gurwick et al., 2008

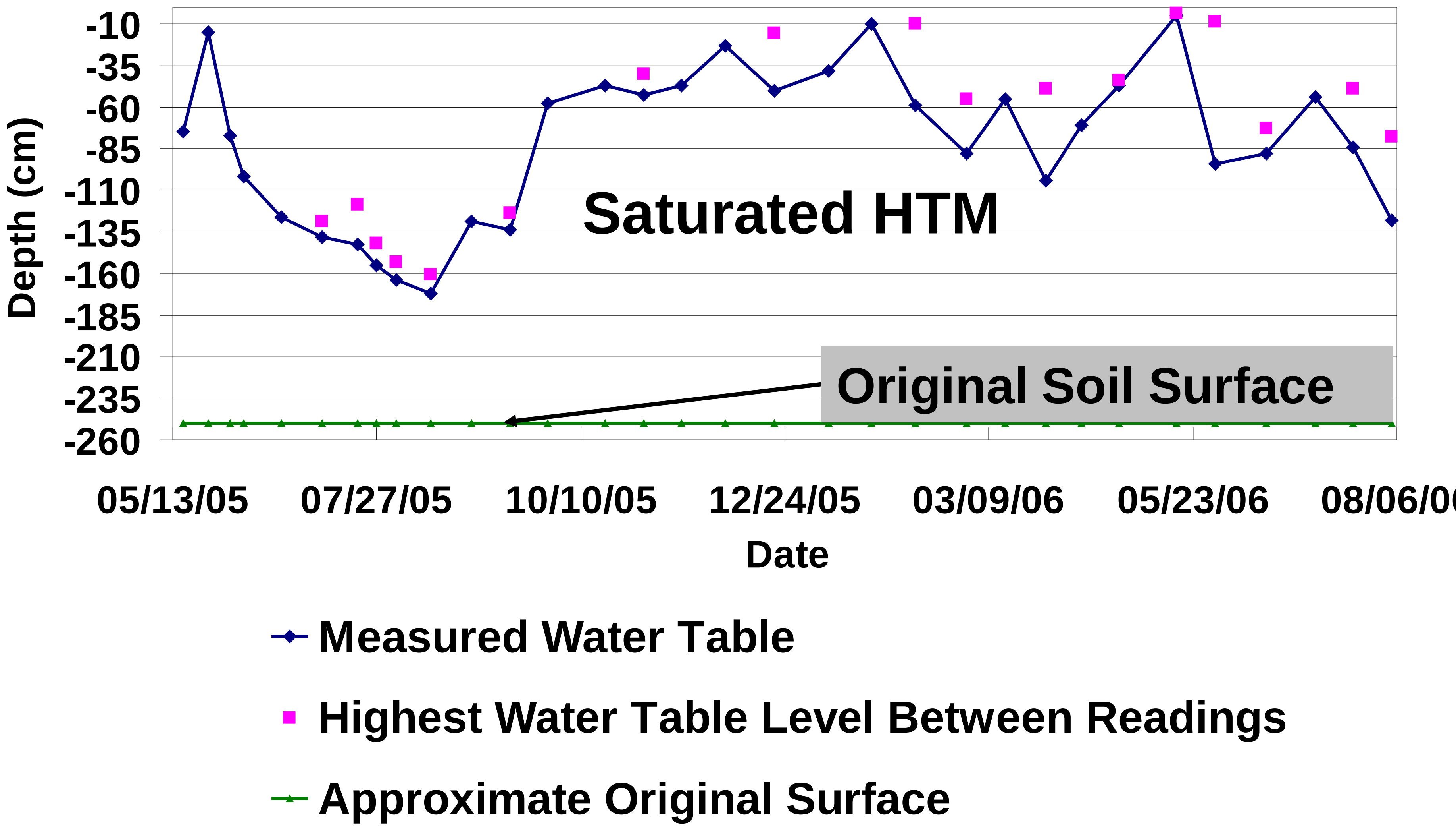
regardless of depth C-mineralization was

O>A>Ab>A/C, C/A, and B horizons

Anthropogenic Soils, Carbon, and Reducing Conditions

Water Table Fluctuation:

Human Transported Materials (HTM) over a Tidal Marsh



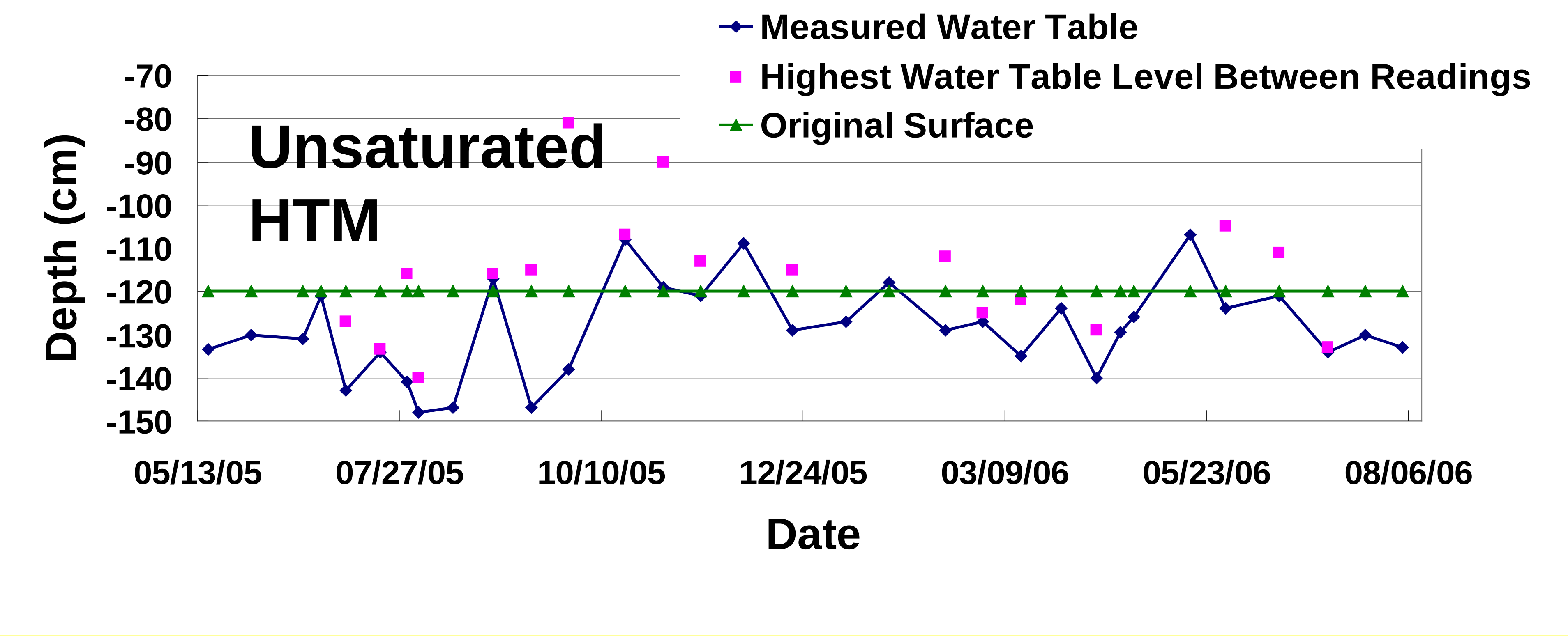
Donohue et al., 2009

Carbon Forms Were Abundant in the

Of the 18 anthropogenic soils examined , 16 developed RMFs in HTM at depths corresponding to the depth of the SHWT and presence of carbon suggesting the potential for denitrification

Water Table Fluctuation:

HTM over Sandy Unconsolidated Shore



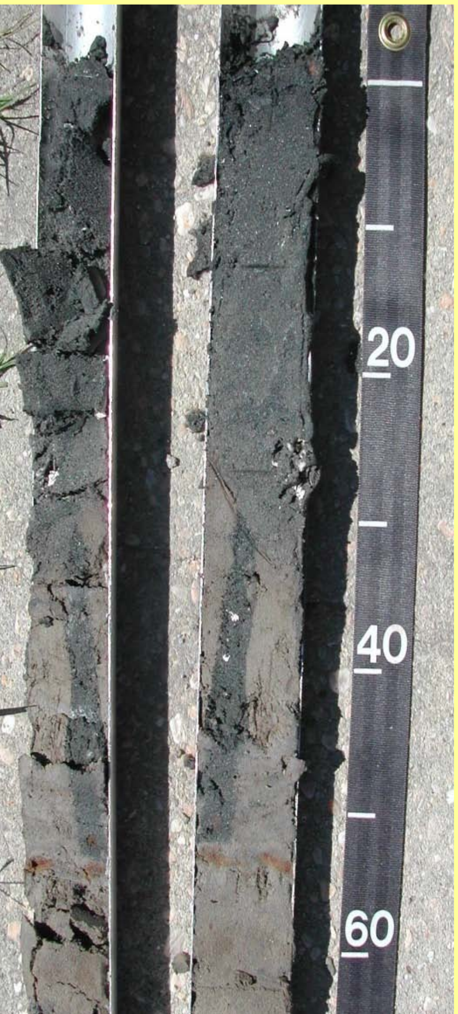
Carbon Accounting

Subaqueous

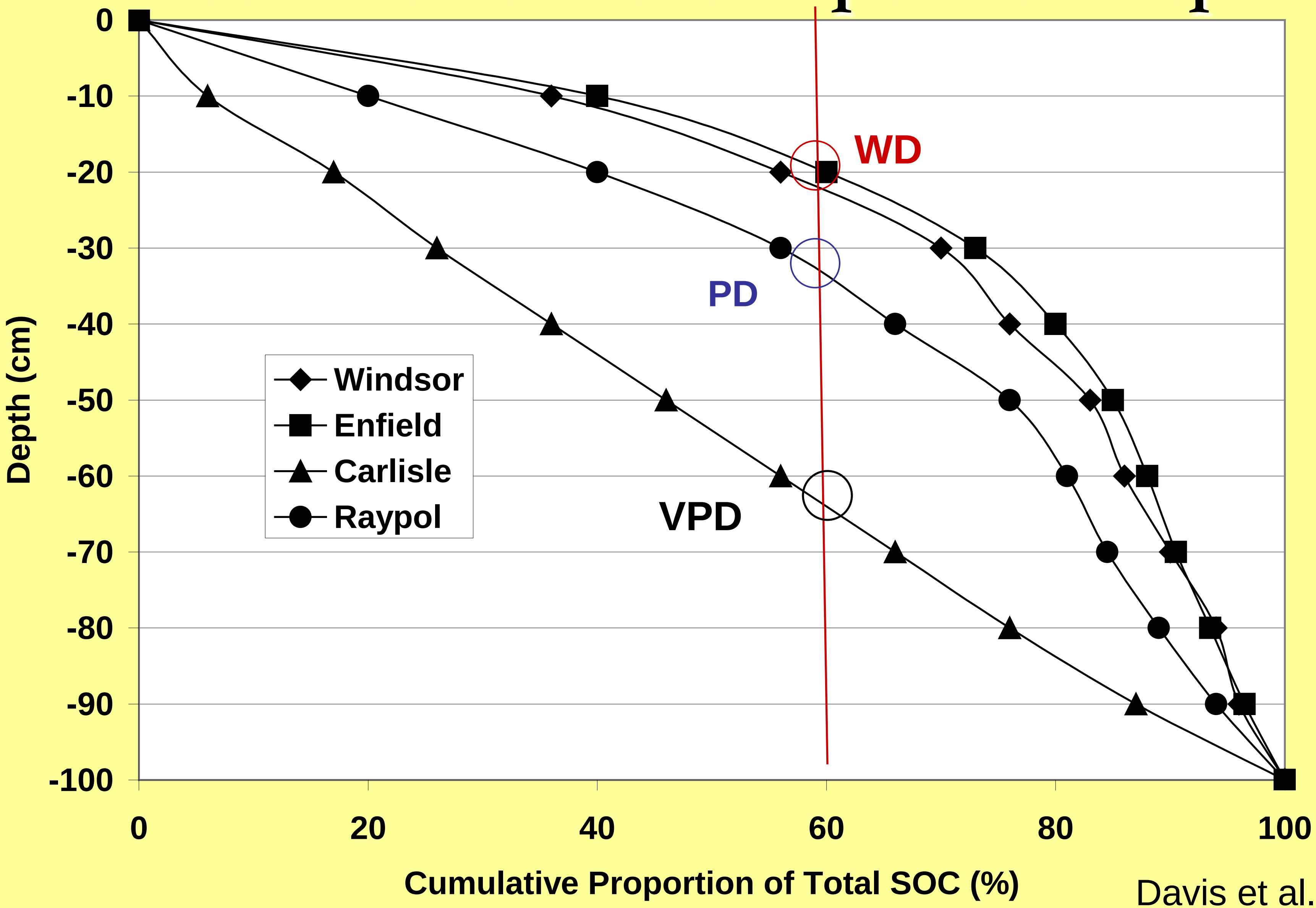
Water

Riparian

Upland



What Percentage of the Total Carbon Pool Occurs above a Specified Depth

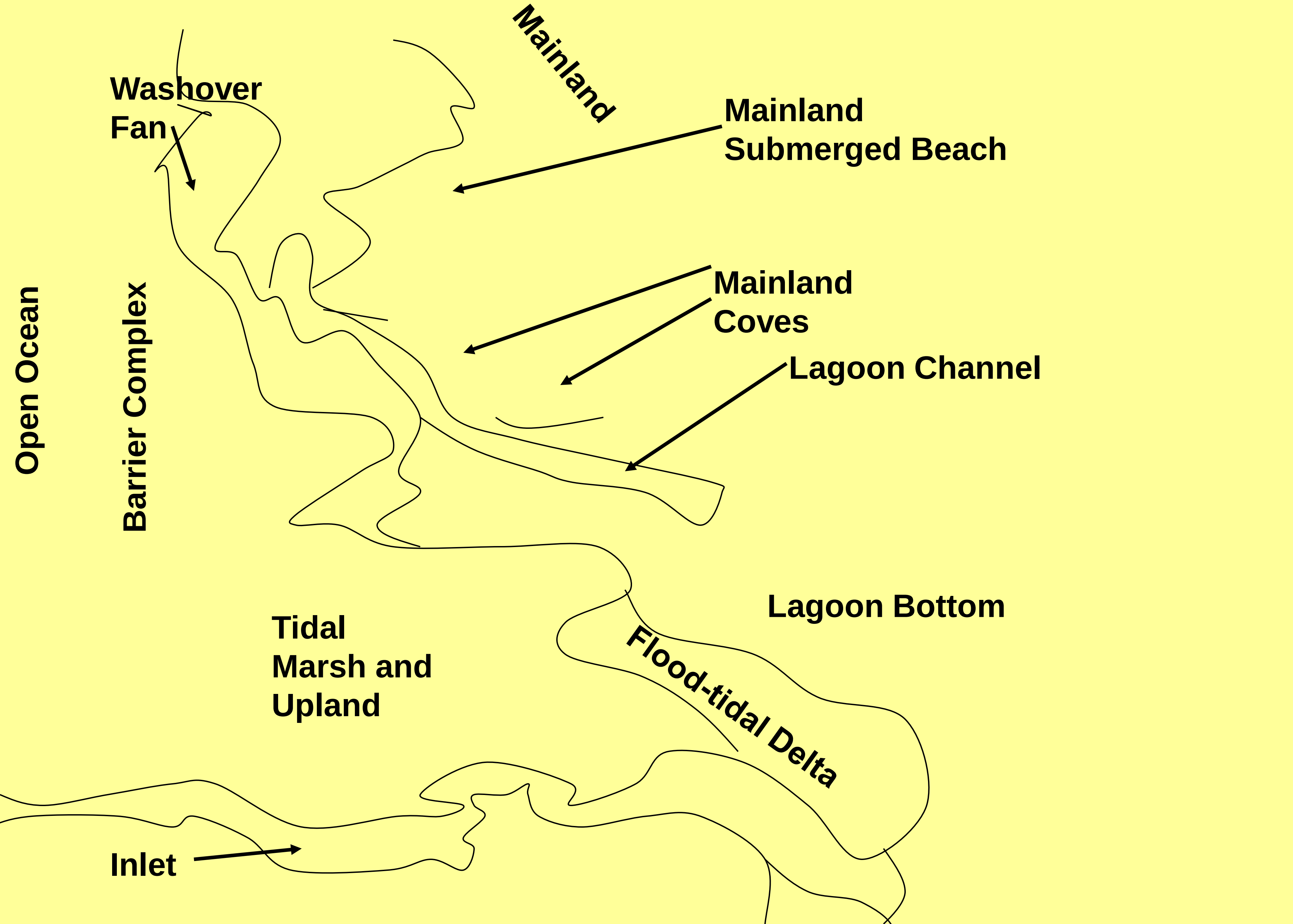


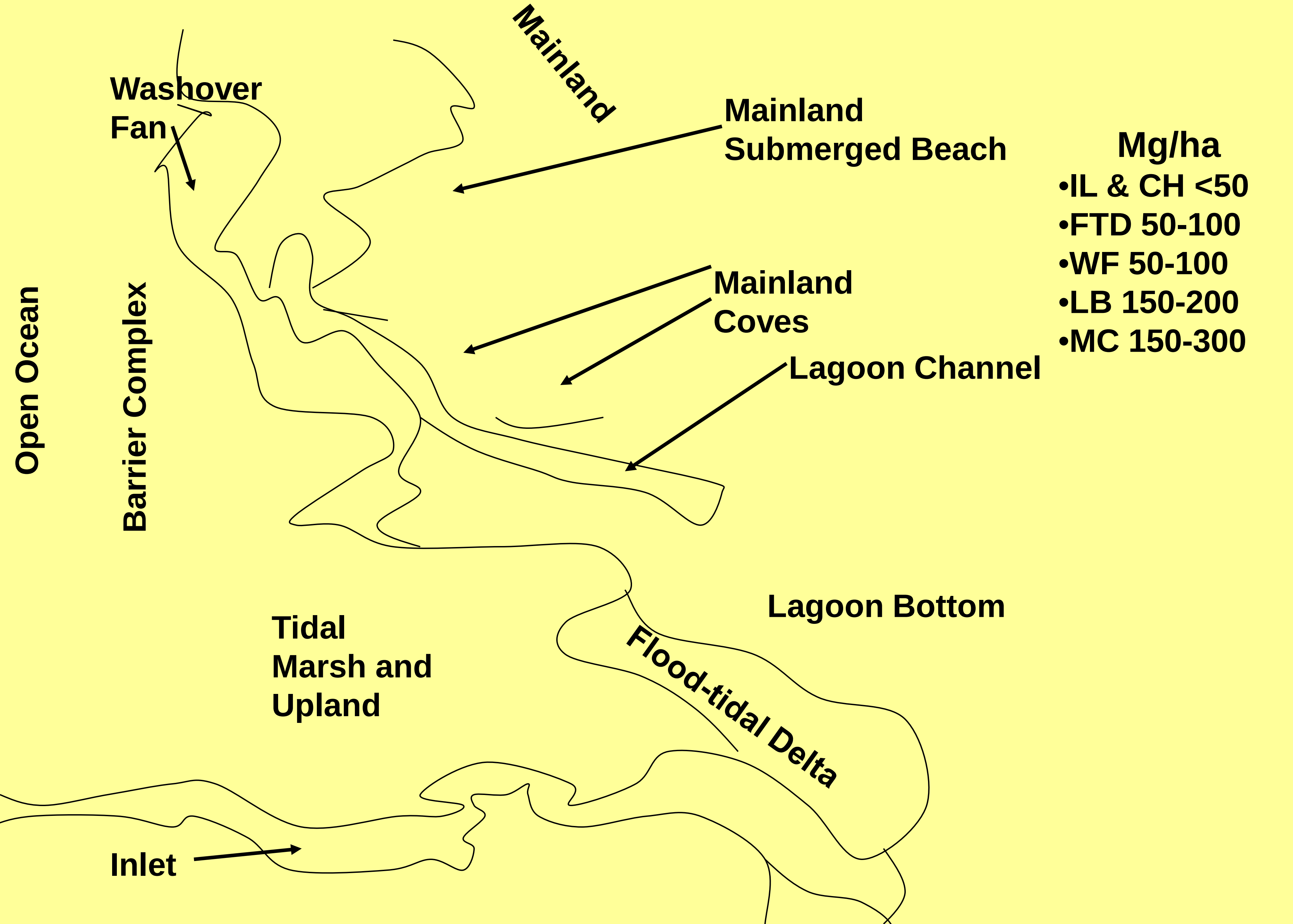
Davis et al., 2004

Carbon Pools by Drainage Class for Forest Ecosystems

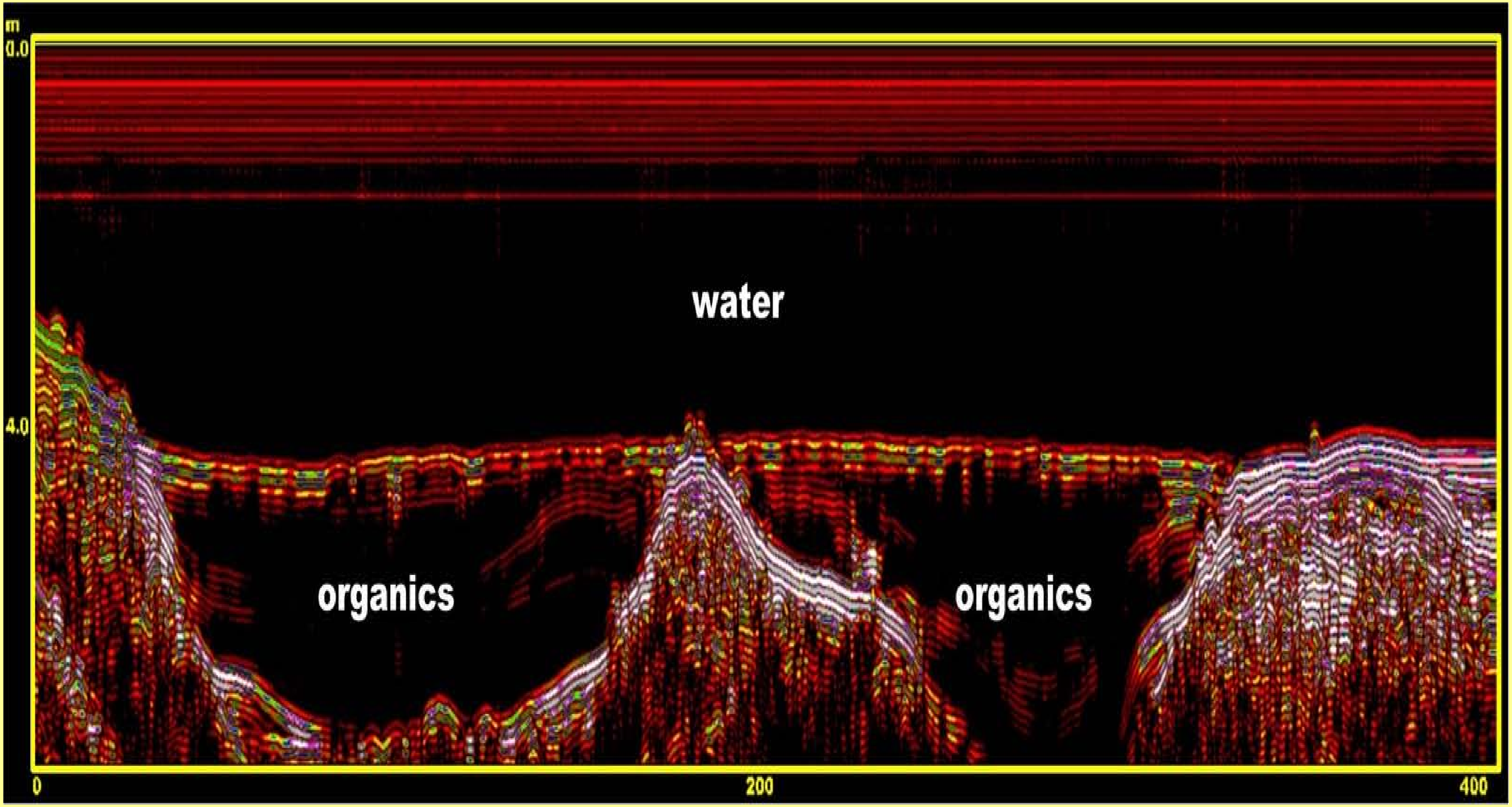
Drainage Class	Number of Pedons	Carbon Pools Mean (Mg C ha^{-1})	Carbon Pools Range (Mg C ha^{-1})
Excessively	20	110	94-127
Well	32	150	96-175
Moderately Well	12	154	110-245
Poorly (palustrine)	20	187	129-245
Poorly (alluvial)	29	246	117-495
Very Poorly	30	586	469-703
Subaqueous*	42	155	45-285

* Subaqueous are <u>not</u> Forested

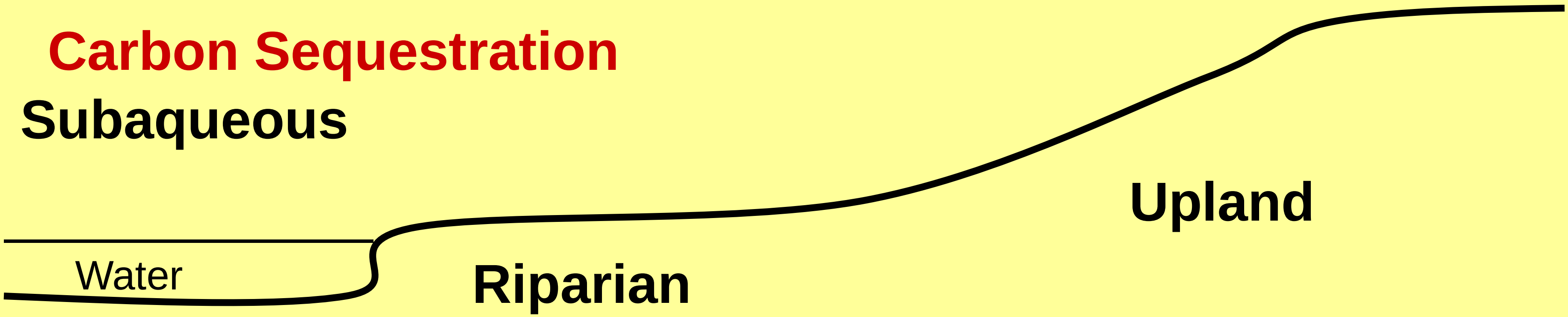

Mainland
Washover
Fan
Mainland
Submerged Beach
Mainland
Coves
Lagoon Channel
Open Ocean
Barrier Complex
Lagoon Bottom
Tidal
Marsh and
Upland
Flood-tidal Delta
Inlet

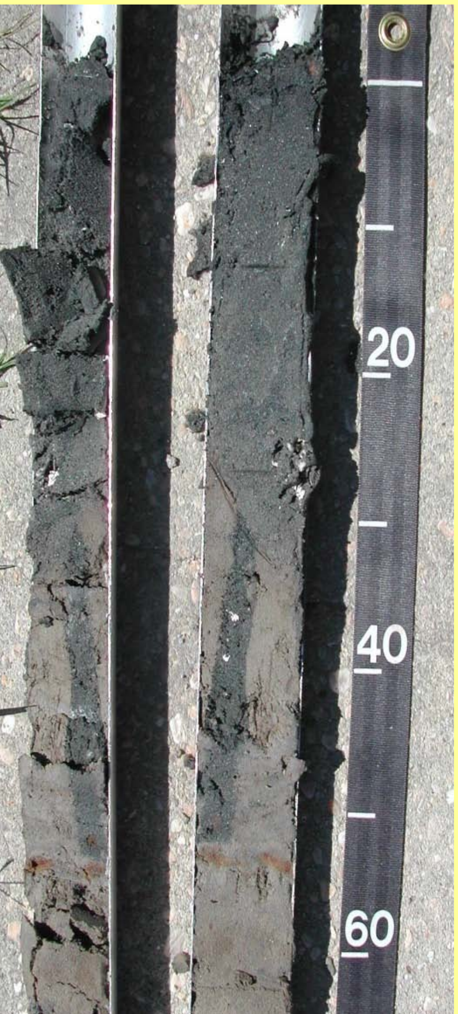

Mainland
Washover
Fan
Mainland
Submerged Beach
Mg/ha
•IL & CH <50
•FTD 50-100
•WF 50-100
•LB 150-200
•MC 150-300
Mainland
Coves
Lagoon Channel
Open Ocean
Barrier Complex
Lagoon Bottom
Tidal
Marsh and
Upland
Flood-tidal Delta
Inlet

Freshwater Lake GPR Subaqueous Soils Image



Carbon Sequestration





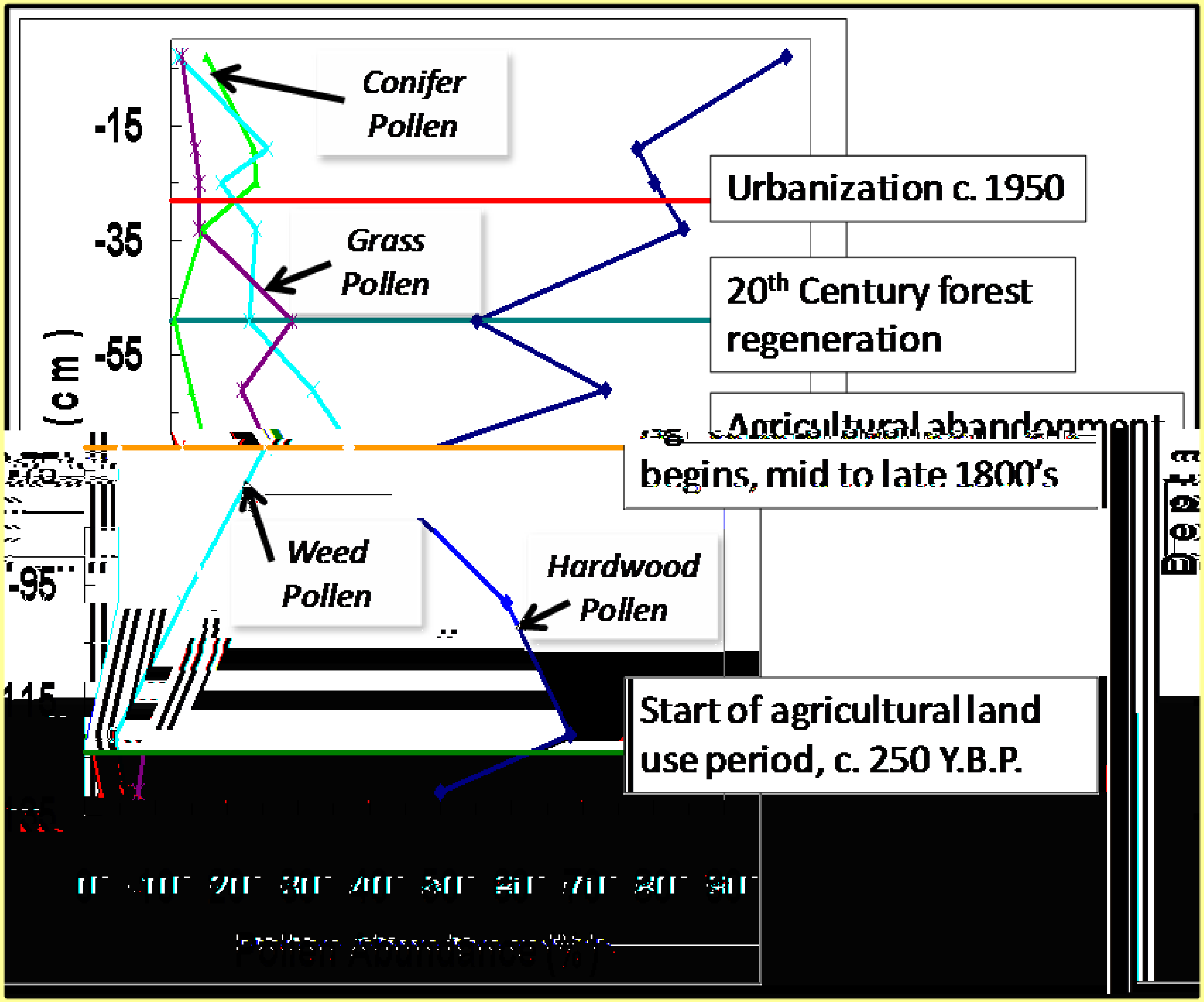
Upland Soil C-Sequestration (Paired Site Approach)

Site	Age (Years)	Forest Type	Difference Between Field and Forest Pools (%)	Whole Soil SOC Sequestration Rate (Mg C ha^{-1} yr^{-1})
St6	25	Coniferous	31	1.42
SR1	28	Coniferous	19	0.92
SNK2	28	Deciduous	12	0.61
S3	29	Deciduous	34	1.91
MC3	37	Coniferous	10	0.39
SBurr1	41	Deciduous	8	0.22
SC2	41	Deciduous	30	1.10
Me1-MA	42	Deciduous	13	0.34
MNK2	45	Deciduous	18	0.79
SG1	46	Deciduous	7	0.49
SR2	47	Coniferous	18	0.90
MNK10	50	Deciduous	22	0.52
SWG1	52	Coniferous	27	0.90
SC2-II	63	Coniferous	29	0.71
ME1	71	Coniferous	34	0.66
MHC1	79	Coniferous	54	1.31
MC2	86	Coniferous	60	1.11

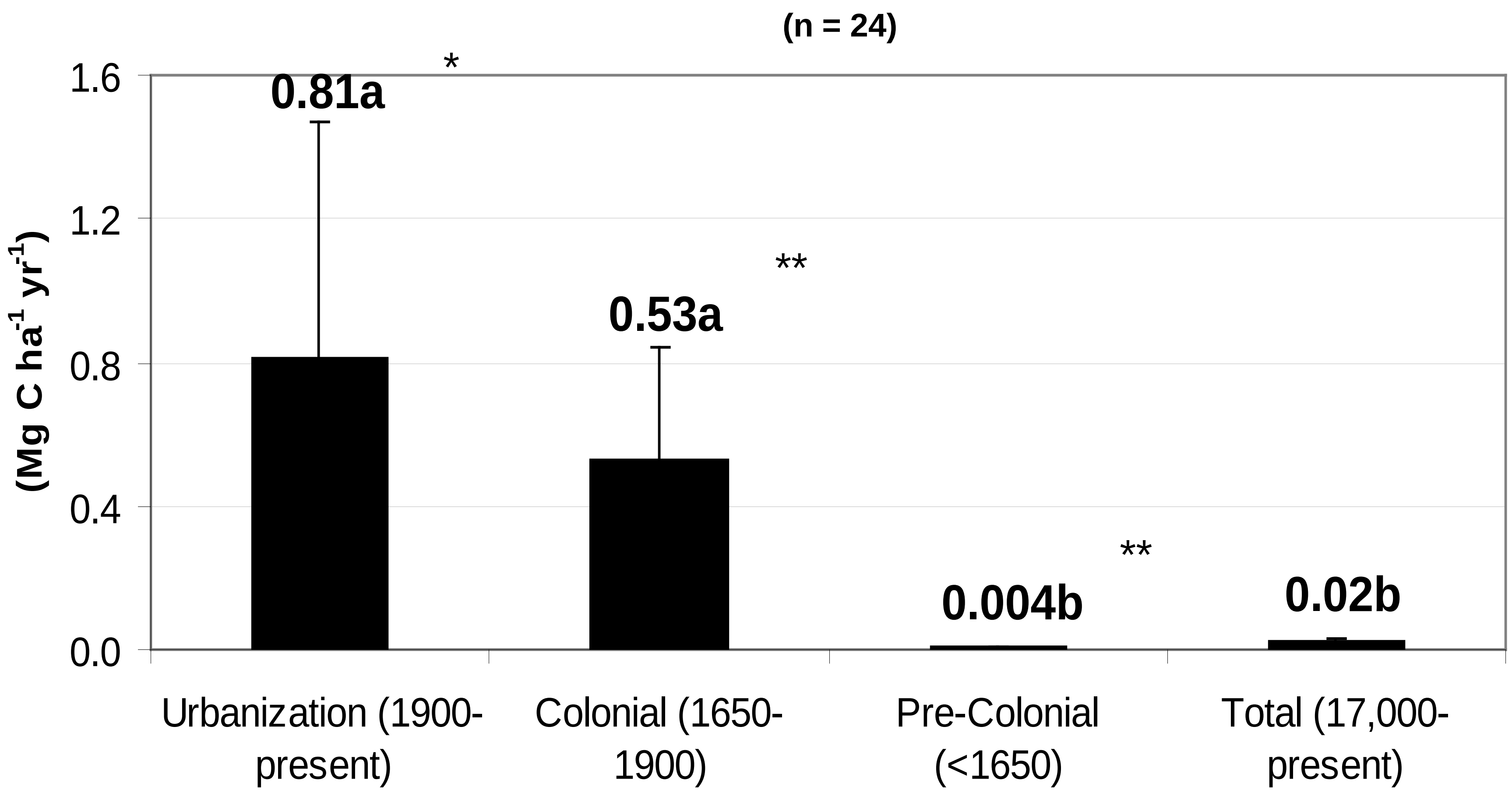
Mean sequestration rate = 0.84 Mg C $ha^{-1}yr^{-1}$.

Richardson, 2005

Multiproxy Approach to Identify Depositional Periods and Land Use History

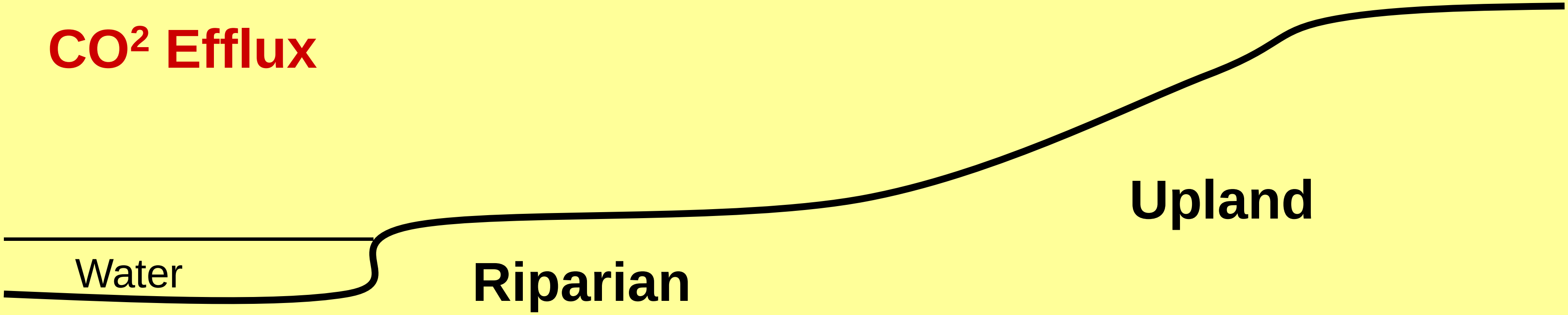


Net Riparian Soil Carbon Sequestration Rates



Data compiled from Donohue (2007) and Ricker (2009)
Means with different letters are significantly different using one-way ANOVA and Tukey's HSD (• = 0.05), error bars represent 1 SD

CO_2 Efflux



Average Contribution of Root Respiration to CO^2 Efflux

	Riparian Zone		Upland	
Site	**Soil Drainage Class**	**Mean Root Respiration (%)**	**Soil Drainage Class**	**Mean Root Respiration (%)**
AMA-RI	PD	67 (28)	ED	37 (24)
EGA-RI	VPD	14 (86)	WD	28 (21)
HSP-RI	PD	77 (8)	ED	45 (33)
SBW-RI	PD	82 (2)	WD	37 (27)
WKC-RI	VPD	72 (8)	WD	14 (36)
Mean	-	63 (44)†	-	32 (56)†

* CV (%) parentheses

† Significantly different based on student's t-test (• = 0.05), p-value 0.002

Ricker, 2009

Conclusions

- Alluvial riparian soils offer the best place on the landscape for denitrification because of the proliferation of carbon throughout the profile.
- Many coastal riparian sites disturbed by anthropogenic activity (i.e. filling of wetlands) still maintain the potential for denitrification.
- Soil carbon pools (for the same land use) vary across the landscape as a function of soil wetness.
- Carbon pools on subaqueous soil landscapes are essentially equivalent to subaerial soils.
- The amount of energy on the subaqueous landscape (or particle-size distribution as a surrogate) dictates carbon pool quantity (less energy-more carbon).

Conclusions

- Aggrading forest soils in southern New England are accumulating carbon at a rate of about 0.84 Mg C $ha^{-1}yr^{-1}$
- Carbon has been accumulating at about the same rate over the last 100 years riparian zone soils along 1st and 2nd order streams
- Total CO^2 flux is similar between uplands and riparian soils; however (apparently), root contributions to the flux are greater in riparian soils